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(54) Recording sheets containing amino acids, hydroxy acids, and polycarboxyl compounds.

(57) A recording sheet which comprises a paper substrate and a material selected from the group consisting of monomeric amino acids, monomeric hydroxy acids, monomeric polycarboxyl compounds, and mixtures thereof. Another embodiment of the present invention is directed to a recording sheet which comprises a substrate and a material selected from the group consisting of monomeric amino acids, monomeric hydroxy acids, and mixtures thereof.

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The present invention is directed to recording sheets, such as transparency materials, filled plastics, papers, and the like. More specifically, the present invention is directed to recording sheets particularly suitable for use in ink jet printing processes.

South African Patent Application 924,610 discloses a transparent recording sheet suitable for making visual transparencies which comprises a thin transparent film backing bearing on at least one major surface thereof an ink jet receptive layer comprising from 1% to 10% of at least one acid having a pKa of from 2 to 6, said acid being selected from the group consisting of aryl monocarboxylic acids, aryloxy monocarboxylic acids, alkyl carboxylic acids having alkyl groups containing at least 11 carbon atoms, dicarboxylic acids, tricarboxylic acids, and pyridinium salts, and at least one liquid-absorbent polymer comprising from 90% to 99% aprotic constituents, wherein said sheet shows reduced fading when imaged with an ink containing triarylmethane dye and at least one nucleophile over an identical composition containing no protic organic-solvent-soluble additive.

While known compositions and processes are suitable for their intended purposes, a need remains for improved recording sheets. In addition, there is a need for improved recording sheets suitable for use in ink jet printing processes. Further, a need remains for recording sheets which exhibit rapid drying times when imaged with aqueous inks. Additionally, there is a need for recording sheets which enable precipitation of a dye from a liquid ink onto the sheet surface during printing processes. A need also remains for recording sheets which are particularly suitable for use in printing processes wherein the recorded substrates are imaged with liquid inks and dried by exposure to microwave radiation. Further, there is a need for recording sheets coated with a discontinuous, porous film. There is also a need for recording sheets which, subsequent to being imaged with an aqueous ink, exhibit reduced curling.

It is an object of the present invention to provide recording sheets with the above noted advantages.

These and other objects of the present invention (or specific embodiments thereof) can be achieved by providing a recording sheet which comprises a paper substrate and a material selected from the group consisting of monomeric amino acids, monomeric hydroxy acids, monomeric polycarboxyl compounds, and mixtures thereof. Another embodiment of the present invention is directed to a recording sheet which comprises a substrate and a material selected from the group consisting of monomeric amino acids, monomeric hydroxy acids, and mixtures thereof.

The recording sheets of the present invention comprise a substrate and at least one compound selected from the group consisting of amino acids, hydroxy acids, polycarboxyl compounds, and mixtures thereof. Any suitable substrate can be employed. Examples include transparent materials, such as polyester, including Mylar™, available from E.I. Du Pont de Nemours & Company, and the like, with polyester such as Mylar™ being preferred in view of its availability and relatively low cost. The substrate can also be opaque, including opaque plastics. Filled plastics can also be employed as the substrate, particularly when it is desired to make a "never-tear paper" recording sheet. Paper is also suitable, including plain papers such as Xerox® 4024, diazo papers, or the like.

Further alternative substrates are mentioned in U.S. application S.N. 08/196,679.

The substrate can be of any effective thickness. Typical thicknesses for the substrate are from about 50 to about 500 μm, and preferably from about 100 to about 125 μm, although the thickness can be outside these ranges.

Situated on the substrate of the present invention is an additive material selected from the group consisting of amino acids, hydroxy acids, polycarboxyl compounds, and mixtures thereof.

Amino acids generally are those compounds having both an amine functional group and an acid functional group. Examples of suitable amino acids include (I) those of the general formula R_1-$(CH_2)_n$-CH_2-(NHR_3)-COOH, wherein R_1 is selected from the group consisting of alkyl, phenyl, hydroxyl, mercaptyl, sulfonic acid, alkyl sulfonic acid, alkyl mercaptyl, phenol, thio, carboxyl, indole, acetamide alkane, 1-alkyl indole, imidazole, aminophenyl, carboxy alkyl, amido alkyl, glutamyl, amino carbonyl, alkyl thio alkyl, amino alkyl, dihydroxy phenyl, vinyl, allyl, amino sulfamoyl, guanidyl alkane, benzyloxy phenyl, S-carbamyl, dicarboxy alkyl, carbobenzyloxy amine, S-trityl, tert-alkoxy carbonyl amine, S-tert alkylthio, S-carboxyalkyl, alkyl sulfoxide alkane, alkyl sulfoximine, hydroxy alkyl, mercaptyl alkyl, thiazolyl, aminoalkane, and amine, R_2 is hydrogen, R_3 is selected from the group consisting of hydrogen, carbobenzyloxy, glycyl, N-tert-butoxy carbonyl, and acetyl, and n represents the number of repeating units, such as (a) when $R_1 = CH_3$, $R_2 = H$, $R_3 = H$, and n varies from 0 to 5, including (1) n = 0, alanine $CH_3CH(NH_2)COOH$ (Aldrich 13,522-4, 16,265-5, A2, 680-2); (2) n = 1, 2-aminobutyric acid $CH_3(CH_2)CH(NH_2)COOH$ (Aldrich 16,266-3, 11,612-2, 23,438-9); (3) n = 2, norvaline $CH_3(CH_2)_2CH(NH_2)COOH$ (Aldrich 22,284-4); (4) n = 3, norleucine $CH_3(CH_2)_3CH(NH_2)COOH$ (Aldrich 17,109-3); (5) n = 5, 2-amino caprylic acid $CH_3(CH_2)_5CH(NH_2)COOH$ (Aldrich 21,770-0); (b) when $R_1 = C_6H_5$, R_2=H, R_3=H, and n varies from 0 to 5, including (1) n = 0, 2-phenyl glycine $C_6H_5CH(NH_2)COOH$ (Aldrich P2, 550-7); (2) n = 1, phenyl alanine $C_6H_5CH_2CH(NH_2)COOH$ (Aldrich 14,796-6, P1,700-8); (3) n = 2, homophenyl alanine $C_6H_5(CH_2)_2CH(NH_2)COOH$ (Aldrich 29,435-7, 29,436-5, 29,437-3); (c) when n = 1, R_2 = H, R_3 = H, and R_1 varies, including (1) R_1 =

HO, such as serine $HOCH_2CH(NH_2)COOH$ (Aldrich S259-7); (2) R_1 = HS, such as cysteine $HSCH_2CH(NH_2)COOH$ (Aldrich 86,167-7, 16,814-9); (3) R_1 = HO_3S, such as cysteic acid monohydrate $HO_3SCH_2CH(NH_2)COOH{\cdot}H_2O$ (Aldrich 85,189-2); (4) R_1 = HO_3SCH_2, such as homocysteic acid $HO_3SCH_2CH_2CH(NH_2)COOH$ (Aldrich 21,974-6); (5) R_1=$(CH_3)_2SH$, such as leucine $(CH_3)_2CHCH_2CH(NH_2)COOH$ (Aldrich 16,272-8); (6) R_1 = HOC_6H_4, such as tyrosine 4-$HOC_6H_4CH_2CH(NH_2)COOH$ (Aldrich 85,545-6, 14,572-6, T9,040-9); (7) R_1 = S, such as cystine $[S\text{-}CH_2CH(NH_2)COOH]_2$ (Aldrich C12,200-9, 28,546-3, 29,867-0); (8) R_1 = HOOC, such as aspartic acid $HOOCCH_2CH(NH_2)COOH$ (Aldrich A9,309-7, 21,909-6, A9,310-0); (9) R_1 = $[C_5H_3(=O)(OH)N]$, such as leucenol and mimosine $C_5H_3(=O)(OH)NCH_2CH(NH_2)COOH$ (Aldrich M8,761-4); (10) R_1=$CH_3CONH(CH_2)_3$, such as acetyl-L-lysine $CH_3CONH(CH_2)_3CH_2CH(NH_2)COOH$ (Aldrich 11,579-7); (11) R_1=C_8H_6NH, such as tryptophan $C_8H_6NHCH_2CH(NH_2)COOH$ (Aldrich 15,628-0, 16,269-8, T9,020-4); (12) R_1=$(C_6H_5)_3CS$, such as (S)-trityl-L-cysteine $(C_6H_5)_3CSCH_2CH(NH_2)COOH$ (Aldrich 16,473-9); (13) R_1 =$C_8H_6N(CH_3)$, such as 1-methyl D,L-tryptophan $C_8H_6N(CH_3)CH_2CH(NH_2)COOH$ (Aldrich 86,064-6); (14) R_1 = $C_3H_3N_2$, such as histidine $C_3H_3N_2CH_2CH(NH_2)COOH$ (Aldrich 15,168-8, 21,973-8); (15) R_1 = $H_2NC_6H_4$, such as 4-amino phenylalanine hydrate $H_2NC_6H_4CH_2CH(NH_2)COOH{\cdot}xH_2O$ (Aldrich 85,870-6, 34,824-4, 34,825-2); (16) R_1 = $HOOCCH_2$, such as glutamic acid $HOOCCH_2CH_2CH(NH_2)COOH$ (Aldrich 12,843-0), 85,735-1 and G279-6); (17) R_1 = H_2NCOCH_2, such as glutamine $H_2NCOCH_2CH_2CH(NH_2)COOH$ (Aldrich G,320-2); (18) R_1 = $HOOCCH_2CH_2CH(COOH)NHCOCH_2$, such as γ-L-glutamyl-L-glutamic acid $HOOCCH_2CH_2CH(COOH)NHCOCH_2$ $CH_2CH(NH_2)COOH$ (Aldrich 85,927-3); (19) R_1 =$C_6H_5CH_2CH(COOH)NHCOCH_2$, such as N-(γ-L-glutamyl) phenylalanine $C_6H_5CH_2CH(COOH)NHCOCH_2CH_2CH(NH_2)COOH$ (Aldrich 86,020-4); (20) R_1 = H_2NCO, such as asparagine $H_2NCOCH_2CH(NH_2)COOH$ (Aldrich A9,300-3, 21,911-8, 15,357-5, 17,653-2); (21) R_1=$H_2NCONH(CH_2)_2$, such as citrulline $H_2NCONH(CH_2)_3CH(NH_2)COOH$ (Aldrich 85,572-3, C8,370-8); (22) R_1 = $C_2H_5SCH_2$, such as ethionine $C_2H_5SCH_2CH_2CH(NH_2)COOH$ (Aldrich 21,932-0, 10,040, 21,929-9); (23) R_1 = $H_2N(CH_2)_3$, such as lysine $H_2N(CH_2)_4CH(NH_2)COOH$ (Aldrich 27,414-3, 16,971-4) and lysine hydrate $H_2N(CH_2)_4CH(NH_2)COOH{\cdot}H_2O$ (Aldrich 28, 170-0, 28,267-7); (24) R_1=$(HO)_2C_6H_3$, such as DOPA [3-(3,4-dihydroxy phenyl)-alanine] $(HO)_2C_6H_3CH_2CH(NH_2)COOH$ (Aldrich 10,216-4 and 15,431-8); (25) R_1=$(H_2C{=}CH)$, such as 2-amino-4 pentanoic acid $H_2C{=}CHCH_2CH(NH_2)COOH$ (Aldrich 28,501-3, 17,344-4); (26) R_1 = $H_2NSO_2CH_2$, such as 2-amino-4-sulfamoyl butyric acid $H_2NSO_2CH_2CH_2CH(NH_2)COOH$ (Aldrich 31,096-4); (27) R_1 = $[H_2NC(=NH)NH(CH_2)_2]$, such as arginine $H_2NC(=NH)NH(CH_2)_3CH(NH_2)COOH$ (Aldrich 85,853-6, A9,240-6); (28) R_1=$C_6H_5CH_2OC_6H_4$, such as carbobenzyl-L-tyrosine $C_6H_5CH_2OC_6H_4CH_2CH(NH_2)COOH$ (Aldrich 85,583-9); (29) R_1 = H_2NCOS, such as S-carbamyl-L-cysteine $H_2NCOSCH_2CH(NH_2)COOH$ (Aldrich 11,578-9); (30) R_1 = $(CH_3)_3COOCNH(CH_2)_3$, such as N-ε(tert-butoxy carbonyl)-L-lysine $(CH_3)_3COOCNH(CH_2)_3CH_2CH(NH_2)COOH$ (Aldrich 35,966-1); (31) R_1 =$(CH_3)_3CSS$, such as S-(tert butylthio)-L-cysteine $(CH_3)_3CSSCH_2CH(NH_2)COOH$ (Aldrich 23,235-1); (32) R_1 = $(HOOC)_2CH$, such as L-γ-carboxy glutamic acid $(HOOC)_2CHCH_2CH(NH_2)COOH$ (Aldrich 28,408-4); (33) R_1 = $C_6H_5CH_2OOCNH(CH_2)_3$, such as N-carbobenzyloxy-L-lysine $C_6H_5CH_2OOCNH(CH_2)_4CH(NH_2)COOH$ (Aldrich C800-8); (34) R_1 = $HOOCCH_2S$, such as S-carboxymethyl-L-cysteine $HOOCCH_2SCH_2CH(NH_2)COOH$ (Aldrich 85,121-3); (35) R_1 = CH_3SCH_2, such as methionine $CH_3S(CH_2)_2CH(NH_2)COOH$ (Aldrich M885-1, 85,590-1, and 15,169-6), (36) R_1=CH_3SOCH_2, such as methionine sulfoxide $CH_3SO(CH_2)_2CH(NH_2)COOH$ (Aldrich 85,126-4); (37) R_1 = $CH_3S(O)(=NH)CH_2$, such as L-methionine sulfoximine $CH_3S(O)(=NH)(CH_2)_2CH(NH_2)COOH$ (Aldrich 85,589-8); (38) R_1 = $HOCH_2$ such as homoserine $HOCH_2CH_2CH(NH_2)COOH$ (Aldrich 21,977-0); (39) R_1 = $HSCH_2$, such as homocysteine $HSCH_2CH_2CH(NH_2)COOH$ (Aldrich 19,314-3, 21,974-6); (40) R_1 = C_3H_2NS, such as 3-(2-thiazolyl)-D,L-alanine $C_3H_2NSCH_2CH(NH_2)COOH$ (Aldrich 86,219-3); (d) when n = 1, R_2 = H, R_3=$COCH_2NH_2$, and R_1 varies, including (1) R_1=$(CH_3)_2CH$, such as glycyl L-leucine $(CH_3)_2CHCH_2CH(NHCOCH_2NH_2)COOH$ (Aldrich 85,007-1); (2) R_1 = $4(HO)C_6H_4$, such as glycyl L-tyrosine dihydrate $4(HO)C_6H_4CH_2CH(NHCOCH_2NH_2)COOH{\cdot}2H_2O$ (Aldrich 85,872-2); (3) R_1 = $HOOCCH_2$, such as glycyl-L-glutamic acid $HOOCCH_2CH_2CH(NHCOCH_2NH_2)COOH$ (Aldrich 85,160-4); (e) when n = 0, R_2 = H, R_3 = H, and R_1 varies, including (1) R_1 = $CH_3CH(OH)$, such as threonine $CH_3CH(OH)CH(NH_2)COOH$ (Aldrich T3,422-3); (2) R_1=$(CH_3)_2CH$, such as valine $(CH_3)_2CHCH(NH_2)COOH$ (Aldrich 85,598-7, 16,267-1, V70-5); (3) R_1=$C_2H_5CH(CH_3)$, such as isoleucine $C_2H_5CH(CH_3)CH(NH_2)COOH$ (Aldrich 15,171-8, 29,868-9, 29,865-4); (4) R_1 = HOC_6H_4, such as D-4-hydroxy phenyl glycine $HOC_6H_4CH(NH_2)COOH$ (Aldrich 21,533-3); (5) R_1 = $C_2H_5CH(OH)$, such as 3-hydroxynorvaline $C_2H_5CH(OH)CH(NH_2)COOH$ (Aldrich 28,617-6); (f) when n = 1, R_2 = H, R_3 = $COCH_3$, and R_1 varies, including (1) R_1 = $HOOCCH_2$, such as N-acetyl-L-glutamic acid $HOOCCH_2CH_2CH(NHCOCH_3)COOH$ (Aldrich 85,564-20; (2) R_1 = CH_3SCH_2, such as N-acetyl-methionine $CH_3SCH_2CH_2CH(NHCOCH_3)COOH$ (Aldrich A1,790-0, 85,554-5); (3) R_1 =$C_3H_3N_2$, such as N-α-acetyl-L-histidine monohydrate $C_3H_3N_2CH_2CH(NHCOCH_3)COOH{\cdot}H_2O$ (Aldrich 85,754-8); (4) R_1 = C_8H_6NH, such as N-acetyl tryptophan $C_8H_6NHCH_2CH(NHCOCH_3)COOH$ (Aldrich 85,580-4); (5) R_1 = HS, such as N-acetyl-L-cysteine $HSCH_2CH(NHCOCH_3)COOH$ (Aldrich 13,806-1); (6) R_1 = C_6H_5, such as N-acetyl-L-phenylalanine $C_6H_5CH_2CH(NHCOCH_3)COOH$ (Aldrich 85,745-9); (7) N-acetyl-D,L-penicillamine $(CH_3)_2C(SH)CH(NHCOCH_3)COOH$ (Aldrich A1,900-8); (g) when n = 0, R_2 = CH_3, R_3 = H, and R_1 varies, including (1) R_1 =

$(CH_3)_2$, such as 2-aminobutyric acid $(CH_3)_2C(CH_3)(NH_2)COOH$ (Aldrich 85,099-3); (2) R_1 = $4(HO)C_6H_4CH_2$, such as D,L-α-methyl tyrosine $4(HO)C_6H_4CH_2C(CH_3)(NH_2)COOH$ (Aldrich 12,069-3); (3) R_1 =$(HO)_2C_6H_3CH_2$, such as (-)-3-(3,4-dihydroxyphenyl)-2-methyl-L-alanine sesquihydrate $(HO)_2C_6H_3CH_2C(CH_3)(NH_2)COO$-$H \cdot 1.5H_2O$ (Aldrich 85,741-6); (4) R_1=$C_6H_5CH_2$, such as α-methyl-D,L-phenylalanine $C_6H_5CH_2C(CH_3)(NH_2)$ $COOH$ (Aldrich 28,665-6); (h) when n = 1, R_2 = H, R_3 = $[COCH(NH_2)CH_3]$, and R_1 varies, including (1) R_1 = C_2H_5, such as D,L-alanyl-DL-norvaline $C_2H_5CH_2CH[NHCOCH(NH_2)CH_3]COOH$ (Aldrich 85,001-2); (2) R_1=C_6H_5, such as D,L-alanyl-D,L-phenyl alanine $C_6H_5CH_2CH[NHCOCH(NH_2)CH_3]COOH$ (Aldrich 85,002-0); (i) when n = 0, R_2 = R_3 = $[COOC(CH_3)_3]$, and R_1 varies, including (1) R_1=$C_2H_5CH(CH_3)$, such as N-(tert-butoxy carbonyl)-L-isoleucine $C_2H_5CH(CH_3)CH[NHCOOC(CH_3)_3]COOH$ (Aldrich 35,965-3); (2) R_1 = $H_2N(CH_2)_4$, such as N-α-(tert butoxy carbonyl)-L-lysine $H_2N(CH_2)_4CH[NHCOOC(CH_3)_3]COOH$ (Aldrich 35,968-8); (3) R_1 = $C_6H_5CH_2$, such as N(tert-butoxy carbonyl)-L-phenylalanine $C_6H_5CH_2CH[NHCOOC(CH_3)_3]COOH$ (Aldrich 13,456-2); (4) R_1 = $HOCH_2$, such as N-(tert-butoxy carbonyl)-L-serine $HOCH_2CH[NHCOOC(CH_3)_3]COOH$ (Aldrich 35,969-6); (5) R_1 = $CH_3CH(OH)$, such as N-(tert-butoxy carbonyl)-L-threonine $CH_3CH(OH)CH$-$[NHCOOC(CH_3)_3]COOH$ (Aldrich 35,971-8); (6) R_1 = $(CH_3)_2CH$, such as N-(tert-butoxy carbonyl)-L-valine $(CH_3)_2CHCH[NHCOOC(CH_3)_3]COOH$ (Aldrich 35,972-6); (j) when n = 0, R_2 = H, R_3 = $[COOCH_2C_6H_5]$, and R_1 varies, including (1) R_1 = CH_3, such as carbobenzyloxy-alanine $CH_3CH[NHCOOCH_2C_6H_5]COOH$ (Aldrich 85,069-1, 15,689-2); (2) R_1 = $H_2NC(=NH)NH(CH_2)_3$, such as N-carbobenzyloxy-L-arginine $H_2N(=NH)NH(CH_2)_3CH[NHCOOCH_2C_6H_5]COOH$ (Aldrich 16,263-9); (3) R_1 = H_2NCOCH_2, such as carbobenzyloxy-L-asparagine $H_2NCOCH_2CH[NHCOOCH_2C_6H_5]COOH$ (Aldrich C640-4); (4) R_1 = $HOOCCH_2$, such as N-carbobenzyloxy-L-aspartic acid $HOOCCH_2CH[NHCOOCH_2C_6H_5]COOH$ (Aldrich 16,262-0); (5) R_1 = $H_2NCOCH_2CH_2$, such as carbobenzyloxy-L-glutamine $H_2NCOCH_2CH_2CH[NHCOOCH_2C_6H_5]COOH$ (Aldrich 16,264-7); (6) R_1 = $H_2N(CH_2)_4$, such as N-(carbobenzyloxy)-L-lysine $H_2N(CH_2)_4CH[NHCOOCH_2C_6H_5]COOH$ (Aldrich 35,979-3); (7) R_1 = $C_6H_5CH_2$, such as N-(carbobenzyloxy)-L-phenylalanine $C_6H_5CH_2CH$-$[NHCOOCH_2C_6H_5]COOH$ (Aldrich 35,980-7); (8) R_1 = $HOCH_2$, such as carbobenzyloxy-serine $HOCH_2CH[NHCOOCH_2C_6H_5]COOH$ (Aldrich 86,070, C900-4); (9) R_1=$(CH_3)_2CH$, such as carbobenzyloxy-L-valine $(CH_3)_2CHCH[NHCOOCH_2C_6H_5]COOH$ (Aldrich 29,352-0); and the like. Also suitable are (II) amino acids of the general formula R_1-$(CH_2)_n$-CH_2-(NHR_2)-$COOH \cdot HX$, wherein R_1 is selected from the group consisting of amine, amino alkane, guanidyl alkane, and phenyl alkyl, R_2 is hydrogen or alkyl, and X is an anion, such as Cl^-, Br^-, I^-, SO_3^-, or the like, such as (a) when n = 1, R_2 = H, R_3 = H, and R_1 varies, including (1) R_1 = H_2N, such as 2,3-diamino propionic acid monohydrochloride $H_2NCH_2CH(NH_2)COOH \cdot HCl$ (Aldrich 21,963-0); (2) R_1 = H_2N, such as 2,3-diamino propionic acid monohydrobromide $H_2NCH_2CH(NH_2)COOH \cdot HBr$ (Aldrich D2,400-5); (3) when R_1 = $H_2N(CH_2)_2$, such as ornithine hydrochloride $H_2N(CH_2)_3CH(NH_2)COOH \cdot HCl$ (Aldrich 22,285-2, Aldrich 0-830-5); (4) R_1 = $[H_2NC(=NH)NH(CH_2)_3]$, such as homoarginine hydrochloride $H_2NC(=NH)NH(CH_2)_3CH_2CH(NH_2)COOH \cdot HCl$ (Aldrich 15,711-2); (5) R_1 = $[H_2NC(=NH)NH(CH_2)_2]$, such as arginine hydrochloride $H_2NC(=NH)NH(CH_2)_3CH(NH_2)COOH \cdot HCl$ (Aldrich A9,260-0); (6) R_1=H_2NCH_2, such as 2,4-diaminobutyric acid dihydrochloride $H_2NCH_2CH_2CH(NH_2)COOH \cdot 2HCl$ (Aldrich 23,776-0), 85,019-5); (7) R_1 = $H_2N(CH_2)_3$, such as lysine monohydrochloride $H_2N(CH_2)_4CH(NH_2)COOH \cdot HCl$ (Aldrich L460-5, 26,068-1, 28,171-9) and lysine dihydrochloride $H_2N(CH_2)_4CH(NH_2)COOH \cdot 2HCl$ (Aldrich 36,022-8); (8) when R_1 = $C_6H_5CH(CH_3)$ and n = 0, such as β-methyl-D,L-phenyl alanine hydrochloride $C_6H_5CH(CH_3)CH(NH_2)COOH \cdot HCl$ (Aldrich 21,703-4); (9) when R_1 = $H_2N(CH_2)_2$ and R_2 = CH_3, such as 2-methylornithine hydrochloride monohydrate $H_2N(CH_2)_3C(CH_3)(NH_2)COOH \cdot HCl \cdot H_2O$ (Aldrich 28,409-2); and the like.

Also suitable are (III) amino acids of the general formula H_2N-R-COOH and their salts, wherein R is selected from the group consisting of alkane, phenyl, benzyl, alkyl phenyl, phenyl dialkoxy, alkyl cycloalkane, phenol, aminophenyl, diamino phenyl, glycyl, amino benzoyl alkane, amino cycloalkane, methoxy, amino benzophenone, imino phenyl, acetyl alkane, phenyl alkene, phenyl amido alkane, hydroxy alkyl phenyl, dialkyl hydroxy alkyl amino alkane, and benzyl carbonyl, such as (a) when R = $(CH_2)_n$ and n varies from 1 to 12, including (1) [n = 1], glycine H_2NCH_2COOH (Aldrich G620-1) and glycine hydrochloride $H_2NCH_2COOH \cdot HCl$ (Aldrich 21,950-9); (2) [n = 2], β-alanine $H_2N(CH_2)_2COOH$ (Aldrich 23,972-0); (3) [n = 3], 4-aminobutyric acid $H_2N(CH_2)_3COOH$ (Aldrich A4,440-1); (4) [n = 4], 5-aminovaleric acid $H_2N(CH_2)_4COOH$ (Aldrich 12,318-8) and 5-aminovaleric acid hydrochloride $H_2N(CH_2)_4COOH \cdot HCl$ (Aldrich 19,433-6); (5) [n = 5], 6-amino caproic acid $H_2N(CH_2)_5COOH$ (Aldrich A4,460-6); (6) [n = 6], 7-aminoheptanoic acid $H_2N(CH_2)_6COOH$ (Aldrich 28,463-7); (7) [n = 7], 8-amino caprylic acid $H_2N(CH_2)_7COOH$ (Aldrich 85,529-4); (8) [n = 10], 11-amino undecanoic acid $H_2N(CH_2)_{10}COOH$ (Aldrich A8260-5); (9) (n = 11], 12-amino dodecanoic acid $H_2N(CH_2)_{11}COOH$ (Aldrich 15,924-7); (b) wh n R is different in each case, including (1) R = C_6H_4, such as amino benzoic acid $H_2NC_6H_4COOH$ (Aldrich 10,053-6 and 12,767-1) and 3-amino benzoic acid hydrochloride $H_2NC_6H_4COOH \cdot HCl$ (Aldrich 28,965-5); (2) R= $C_6H_4CH_2$, such as 4-amino phenyl acetic acid $H_2NC_6H_4CH_2COOH$ (Aldrich A7,135-2); (3) R=$CH_2C_6H_4$, such as 4-amino methyl benzoic acid $H_2NCH_2C_6H_4COOH$ (Aldrich 28,374-6); (4) R= $C_6H_3(CH_3)$, such as 5-amino-2-methyl benzoic acid $H_2NC_6H_3(CH_3)COOH$ (Aldrich A6,300-7, A6, 280-9, A6220-0); (5) R= $C_6H_2(OCH_3)_2$ such

as 2-amino-4,5-dimethoxy benzoic acid $H_2NC_6H_2(OCH_3)_2COOH$ (Aldrich 25,204-2); (6) R = $CH_2.C_6H_{10}$, such as 4-amino methyl cyclohexane carboxylic acid $H_2NCH_2C_6H_{10}COOH$ (Aldrich 85,765-3); (7) R = C_6H_3-2(OH), such as 5-amino salicyclic acid $H_2NC_6H_3$-2(OH)COOH (Aldrich A7,980-9); (8) R= $H_2NC_6H_3$, such as 3,5-diaminobenzoic acid $(H_2N)_2C_6H_3COOH$ (Aldrich D1280-5); (9) R=$C_6H_4CONHCH_2$, such as 4-aminohippuric acid $H_2NC_6H_4CONHCH_2COOH$ (Aldrich 12,295-5); (10) R=$CH_2CONHCH_2$, such as glycyl glycine $H_2NCH_2CONHCH_2COOH$ (Aldrich G780-1); (11) R=$CH_2(CONHCH_2)_3$ such as glycyl glycyl glycyl glycine H_2NCH_2-$(CONHCH_2)_3COOH$ (Aldrich 86,008-5); (12) R= [$C_6H_4CONHCH_2CH_2$], such as N-(4-aminobenzoyl)-β-alanine $H_2NC_6H_4CONHCH_2CH_2COOH$ (Aldrich 23,347-1); (13) R = $C_6H_4CONH(CH_2)_5$, such as N-(4-aminobenzoyl)-6-aminocaproic acid $H_2NC_6H_4CONH(CH_2)_5COOH$ (Aldrich 23,349-8); (14) R = C_6H_3-1,3-(COOH), such as 5-amino isophthalic acid $H_2NC_6H_3$-1,3-$(COOH)_2$ (Aldrich 18,627-9); (15) R = C_5H_8, such as 1-amino-1-cyclopentane carboxylic acid $H_2NC_5H_8COOH$ (Aldrich A4,810-5); (16) R = C_3H_4, such as 1-amino-1-cyclopropane carboxylic acid hemihydrate $H_2NC_3H_4$ COOH·½H_2O (Aldrich 28,872-0) and 1-amino-1-cyclopropane carboxylic acid hydrochloride $H_2NC_3H_4$ COOH·HCl (Aldrich 30,408-5); (17) R = C_6H_4CH = CH, such as 4-amino cinnamic acid hydrochloride $H_2NC_6H_4CH$ = CHCOOH·HCl (Aldrich A4,710-9); (18) R = $COCH_2CH_2$, such as succinamic acid $H_2NCOCH_2CH_2COOH$ (Aldrich 13,437-6); (19) R = OCH_2, such as carboxymethoxylamine hemihydrochloride $(H_2NOCH_2COOH)_2$·HCl (Aldrich C1,340-8); (20) R = NHC_6H_4, such as 2-hydrazino benzoic acid hydrochloride $H_2NNHC_6H_4COOH$·HCl (Aldrich 32,430-2); (21) R = $CONH(NH_2CONH)CH$, such as allantoic acid (diureidoacetic acid) $(H_2NCONH)_2CHCOOH$ (Aldrich 21,784-0); (22) R=$C_6H_4COC_6H_4NH_2$, such as 2-aminobenzophenone-2'-carboxylic acid $H_2NC_6H_4COC_6H_4NH_2COOH$ (Aldrich 15,327-3); (23) R = $C(=NH)N(CH_3)CH_2$, such as creatine monohydrate $H_2NC(=NH)N(CH_3)CH_2COOH$·$H_2O$ (Aldrich 85,524-3, 29,119-6); and the like.

Also suitable are (IV) imino acids containing NH and COOH groups, such as (1) n-trityl glycine [$(C_6H_5)_3CNHCH_2COOH$] (Aldrich 30,151-5); (2) 2-acetamido acrylic acid $H_2C = C(NHCOCH_3)COOH$ (Aldrich A140-1); (3) 4-acetamido benzoic acid $CH_3CONHC_6H_4COOH$ (Aldrich 13,333-7); (4) α-acetamido cinnamic acid $C_6H_5CH = C(NHCOCH_3)COOH$ (Aldrich 21,385-3); (5) 6-acetamido hexanoic acid $CH_3CONH(CH_2)_5COOH$ (Aldrich 19,430-1); (6) acetamido acetic acid $CH_3CONHCH_2COOH$ (Aldrich A1,630-0); (7) N-(2-mercapto propionyl) glycine $CH_3CH(SH)CONHCH_2COOH$ (Aldrich 28,096-8); and the like.

Also suitable are (V) amino acids of the general formula H_2N-(R)-SO_3H, wherein R is selected from the group consisting of alkane, alkylene oxide, phenyl, naphthyl, amino benzene, and acetamido alkane, such as (a) when R = $(CH_2)_n$ and n varies from 1 to 12, including (1) n = 0, such as sulfamic acid H_2NSO_3H (Aldrich 24,278-0); (2) (n = 1), R=CH_2, such as amino methane sulfonic acid $H_2N(CH_2)SO_3.H$ (Aldrich 12,744-2); (3) (n = 2), R = $(CH_2)_2$, such as α-2-aminoethane sulfonic acid $H_2N(CH_2)_2SO_3H$ (Aldrich 15,224-2); (4) (n = 3), R = $(CH_2)_3$, such as 3-amino-1-propane sulfonic acid $H_2N(CH_2)_3SO_3H$ (Aldrich A7,610-9); (b) when R is different from $(CH_2)_n$, including (1) R = CH_2CH_2O, such as 2-amino ethyl hydrogen sulfate $H_2NCH_2CH_2OSO_3H$ (Aldrich A5,440-7); (2) R = C_6H_4, such as sulfanilic acid $H_2NC_6H_4SO_3H$ (Aldrich 11,273-9); (3) R = $C_{10}H_6$, such as 2-amino-1-naphthalene sulfonic acid $H_2NC_{10}H_6SO_3H$ (Aldrich 29,113-7); (4) R = $H_2NC_6H_3$, such as 2,5-diamino benzene sulfonic acid $(H_2N)_2C_6H_3SO_3H$ (Aldrich 15,350-8); (5) R = $COCH_2NHCH_2CH_2$, such as [N-(2-acetamido) 2-amino ethane sulfonic acid] $H_2NCOCH_2NHCH_2CH_2SO_3H$ (Aldrich 85,760-2); and the like.

Also suitable are (VI) amino acids of the general formula $NH_2(R)P(O)(OH)_2$, wherein R is selected from the group consisting of alkylene oxide, alkane, and phenyl, including (1) when R = CH_2CH_2O, such as 2-amino ethyl dihydrogen phosphate $H_2NCH_2CH_2OP(O)(OH)_2$ (Aldrich 29,286-9); (2) when R=CH_2CH_2, such as 2-aminoethyl phosphonic acid $H_2NCH_2CH_2P(O)(OH)_2$ (Aldrich 26,867-4); (3) when R = $(CH_2)_3$, such as 3-aminopropyl phosphonic acid $(H_2N(CH_2)_3P(O)(OH)_2$ (Aldrich 26,861-5); (4) when R = C_6H_4, such as 4-amino phenyl phosphonic acid $H_2NC_6H_4P(O)(OH)_2$ (Aldrich 29,094-7); and the like.

Hydroxy acids generally are compounds having both a hydroxy functional group and an acid functional group. Examples of suitable hydroxy acids include (I) those of the general formula HO[R]XH, wherein R is selected from the group consisting of alkane, cycloalkane, phenyl, alkoxy phenyl, dialkoxy phenyl, alkyl phenyl, and phenyl alkene and X is an anion, such as COO, SO_3^-, NO_3^-, or the like, including (1) glycolic acid $HOCH_2COOH$ (Aldrich 12473-7); (2) 10-hydroxydecanoic acid $HO(CH_2)_9COOH$ (Aldrich 28,421-1); (3) 12-hydroxydodecanenoic acid $HO(CH_2)_{11}COOH$ (Aldrich 19,878-1); (4) 16-hydroxy hexadecanoic acid $HO(CH_2)_{15}COOH$ (Aldrich 17,749-0); (5)-hydroxy-1-cyclopropane carboxylic acid HOC_3H_4COOH (Aldrich 29,388-1); (6) hydroxy benzoic acid HOC_6H_4COOH (Aldrich H2,000-8, 24,014-1, H2,005-9); (7) 3-hydroxy-4-methoxy benzoic acid $HOC_6H_3(OCH_3)COOH$ (Aldrich 22,010-8); (8) 4-hydroxy-3-methoxy benzoic acid $HOC_6H_3(OCH_3)COOH$ (Aldrich H3,600-1); (9) 4-hydroxy-3,5-dimethoxy benzoic acid 4-(HO)C_6H_2-3,5-$(OCH_3)_2COOH$ (Aldrich S800-5); (10) 3-hydroxy-4,5-dimethoxy benzoic acid $HOC_6H_2(OCH_3)_2COOH$ (Aldrich 26,845-3); (11) 2-hydroxy-3-isopropyl-6-methyl benzoic acid $HOC_6H_2[CH(CH_3)_2](CH_3)COOH$ (Aldrich 33,991-1); (12) 2-hydroxy-6-isopropyl-3-methyl benzoic acid $HOC_6H_2(CH(CH_3)_2](CH_3)COOH$ (Aldrich 34,097-9); (13) hydroxy cinnamic acid HOC_6H_4CH = CHCOOH (Aldrich H2,280-9, H2,300-7, H2,320-1); (14) 3-hydroxy-4-methoxy cinnamic acid $HOC_6H_3(OCH_3)CH$ = CHCOOH (Aldrich 10,301-2); (15) 4-hydroxy-3-methoxy cinnamic acid

$HOC_6H_3(OCH_3)CH = CHCOOH$ (Aldrich 12,870-8); (16) 3,5-dim thoxy-4-hydroxy cinnamic acid $HOC_6H_2(OCH_3)_2CH = CHCOOH$ (Aldrich D13,460-0); (17) 2-hydroxyhippuric acid $HOC_6H_4CONHCH_2COOH$ (Aldrich 13,406-6); (18) hydroxy phenyl acetic acid $HOC_6H_4CH_2COOH$ (Aldrich H,980-4, H4,990-1, H5,000-4); (19) 4-hydroxy-3-methoxy phenyl acetic acid $HOC_6H_3(OCH_3)CH_2COOH$ (Aldrich 14,364-2); (20) D,L-3-(4 hydroxyphenyl) lactic acid hydrate $HOC_6H_4CH_2CH(OH)COOH \cdot xH_2O$ (Aldrich 28,618-4); (21) 4-hydroxyphenyl pyruvic acid $HOC_6H_4CH_2COCOOH$ (Aldrich 11,428-6); (22) 4-hydroxy benzene sulfonic acid $HOC_6H_4SO_3H$ (Aldrich 17,150-6); (23) 3[(1,1-dimethyl-2-hdyroxyethyl) amino]-2-hydroxy propane sulfonic acid $HOCH_2\ C(CH_3)_2\ NHCH_2CH(OH)CH_2SO_3H$ (Aldrich 34,016-2); and the like.

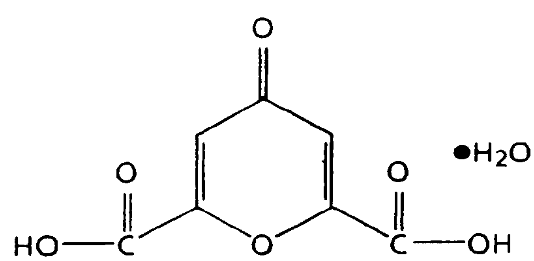
Also suitable are (II) those of the general formula $R_1R_2(OH)COOH$, wherein R_1 and R_2 are each independently selected from the group consisting of alkyl, dialkyl, phenyl, alkoxy, halide, hydroxy, phenyl, dihalide vinyl acrylamide, cycloalkane, and halogenated hydroxyl phenyl, including (1) lactic acid $CH_3CH(OH)COOH$ (Aldrich L5-2); (2) 3-hydroxybutyric acid $CH_3CH(OH)CH_2COOH$ (Aldrich H2,220-5); (3) 2-hydroxyisobutyric acid $(CH_3)_2C(OH)COOH$ (Aldrich 32,359-4, 16,497-6); (4) 2-ethyl-2 hydroxybutyric acid $(C_2H_5)_2C(OH)COOH$ (Aldrich 13,843-6); (5) 2-hydroxy-3-methyl butyric acid (2-hydroxy isovaleric acid) $(CH_3)_2CHCH(OH)COOH$ (Aldrich 21,983 -5); (6) 2-hydroxy-2-methyl butyric acid $C_2H_5C(CH_3)(OH)COOH$ (Aldrich H4,000-9); (7) D,L-2-hydroxy caproic acid $CH_3(CH_2)_3CH(OH)COOH$ (Aldrich 21,980-0); (8) hydroxyisocaproic acid $(CH_3)_2\ CHCH_2CH(OH)COOH$ (Aldrich 21,981-9, 21,982-7); (9) D,L mandelic acid $C_6H_5CH(OH)COOH$ (Aldrich M210-1); (10) (±)-4-methoxy mandelic acid $CH_3OC_6H_4CH(OH)COOH$ (Aldrich 29,688-0); (11) 4-bromo mandelic acid $BrC_6H_4CH(OH)COOH$ (Aldrich B7,120-9); (12) D,L-3-hydroxy-4-methoxy mandelic acid $HOC_6H_3(OCH_3)\ CH(OH)COOH$ (Aldrich 23,542-3); (13) D,L-4-hydroxy-3-methoxy mandelic acid $HOC_6H_3(OCH_3)CH(OH)\ COOH$ (Aldrich 14,880-6); (14) D,L-4-hydroxy mandelic acid monohydrate $HOC_6H_4CH(OH)COOH \cdot H_2O$ (Aldrich 16,832-7); (15) 3-chloro-4-hydroxy benzoic acid hemihydrate $ClC_6H_3(OH)COOH \cdot ½H_2O$ (Aldrich C4,460-5); (16) 2-hydroxy-3-isopropyl benzoic acid $(CH_3)_2CH_4H_3(OH)COOH$ (Aldrich 34,366-8); (17) 3,5-dibromohydroxy benzoic acid $(Br)_2C_6H_2(OH)COOH$ (Aldrich 25,134-8); (18) 3,5-dichloro hydroxy benzoic acid $(Cl)_2C_6H_2(OH)\ COOH$ (Aldrich D6,400-7); (19) benzilic acid $(C_6H_5)_2C(OH)COOH$ (Aldrich B519-4); (20) 2-(4-hydroxy phenoxy) propionic acid $CH_3CH(OC_6H_4OH)COOH$ (Aldrich 32,899-5); (21) α-hydroxy hippuric acid $C_6H_5CONHCH(OH)\ COOH$ (Aldrich 22,387-5); (22) 3,5-diisopropyl salicylic acid $[(CH_3)_2CH]_2C_6H_2$-2-$(OH)COOH$ (Aldrich 13,569-0); (23) 3-chloro-4-hydroxy phenyl acetic acid $ClC_6H_3(OH)CH_2COOH$ (Aldrich 22,452-9); (24) D,L-12-hydroxystearic acid $CH_3(CH_2)_5CH(OH)(CH_2)_{10}COOH$ (Aldrich 21,996-7); (25) tropic acid $C_6H_5CH(CH_2OH)COOH$ (Aldrich T8,920-6); (26) 2-acrylamido glycolic acid monohydrate $H_2C{=}CHCONHCH(OH)COOH \cdot H_2O$ (Aldrich 26,049-5); (27) hexahydromandelic acid $C_6H_{11}CH(OH)COOH$ (Aldrich 30,114-0, 30,115-9); and the like.

Also suitable are (III) those of the general formula $(HO)_2RCOOH$, wherein R is selected from the group consisting of phenyl, acrylic phenyl, phenyl alkyl, phenyl hydroxy, alkyl, naphthyl, alkane amine, diphenyl alkyl, and amino alkyl, including (1) dihydroxy benzoic acid $(HO)_2C_6H_3COOH \cdot ½$ (Aldrich 12,620-9, D10,940-1, 14,935-7, D10,960-6, D10,980-0, D11,000-0); (2) 3,4-dihydroxy cinnamic acid $(HO)_2C_6H_3CH = CHCOOH$ (Aldrich D11,080-9); (3) 3,4-dihydroxy hydro cinnamic acid $(HO)_2C_6H_3CH_2CH_2COOH$ (Aldrich 10,260-1); (4) D,L-3,4-dihydroxy mandelic acid $(HO)_2C_6H_3CH(OH)COOH$ (Aldrich 15,161-0); (5) 3,5-dihydroxy-4-methyl benzoic acid hemihydrate $CH_3C_6H_2(OH)_2COOH \cdot ½\ H_2O$ (Aldrich 31,848-5); (6) dihydroxy naphthoic acid $(HO)_2C_{10}H_5\ COOH$ (Aldrich 28,125-5, 27,529-8, 27,527-1); (7) dihydroxy phenylacetic acid $(HO)_2C_6H_3CH_2COOH$ (Aldrich 16,868-8, 85,021-7); (8) bicine $(HOCH_2CH_2)_2NCH_2COOH$ (Aldrich 16,379-1); (9) 2,2-bis(hydroxymethyl)propionic acid $CH_3C(CH_2OH)_2COOH$ (Aldrich 10,661-5); (10) 4,4-bis(4-hydroxyphenyl) valeric acid $CH_3C(C_6H_4OH)_2CH_2CH_2COOH$ (Aldrich B4,770-7); (11) tris (hydroxymethyl) amino methane succinate $[(HOCH_2)_3CNH_2]_2HOOCCH_2CH_2COOH$ (Aldrich 34,068-5); and the like.

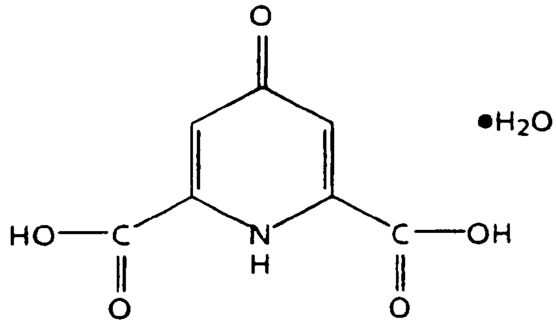
Polycarboxyl compounds generally are those compounds having at least two carboxyl functional groups. Examples of suitable polycarboxyl compounds include (I) aliphatic dicarboxy-functional compounds, including (a) compounds of the general formula $HOOC(CH_2)_nCOOH$ and their derivatives, wherein n represents the number of repeating units, including (1) [n = 0], such as oxalic acid $HOOCCOOH$, such as oxalic acid dihydrate $HOOCCOOH \cdot 2H_2O$ (Aldrich 0-875-5); (2) [n = 1], such as malonic acid $HOOCCH_2COOH$ (Aldrich M129-6); (3) [n = 2], such as succinic acid $HOOC(CH_2)_2COOH$ (Aldrich 13,438-4); (4) [n = 3], such as glutaric acid $HOOC(CH_2)_3COOH$ (Aldrich G340-7); (5) [n = 4], such as adipic acid $HOOC(CH_2)_4COOH$ (Aldrich 24,052-4); (6) [n = 5], such as pimelic acid $HOOC(CH_2)_5COOH$ (Aldrich P,4,500-1); (7) [n = 6], such as suberic acid $HOOC(CH_2)_6COOH$ (Aldrich S520-0); (8) [n = 7], such as azelaic acid $HOOC(CH_2)_7COOH$ (Aldrich A9,615-0); (9) [n = 8], such as sebacic acid $HOOC(CH_2)_8COOH$ (Aldrich S175-2); (10) [n = 9], such as undecanedioic acid $HOOC(CH_2)_9COOH$ (Aldrich 17,796-2); (11) [n = 10], such as 1,10-decane dicarboxylic acid $HOOC(CH_2)_{10}COOH$ (Aldrich D100-9); (12) [n = 11], such as 1,11-undecane dicarboxylic acid $HOOC(CH_2)_{11}COOH$ (Aldrich U60-1); (13) [n = 12], such as 1,12,dodecane dicarboxylic acid $HOOC(CH_2)_{12}COOH$ (Aldrich D22,120-1); (14) [n = 14], such as hexadecan dioic acid $HOOC(CH_2)_{14}COOH$ (Aldrich 17,750-4); (15) [n = 22], such as tetracosane dioic acid $HOOC(CH_2)_{22}COOH$ (Aldrich 30,670-3); der-

ivatives of malonic acid, such as (16) methyl malonic acid $HOOCCH(CH_3)COOH$ (Aldrich MS,405-8); (17) ketomalonic acid monohydrate $HOOCC(OH)_2$ COOH (Aldrich 16,343-0); (18) ethyl malonic acid $HOOC(C_2H_5)COOH$ (Aldrich 10,268-7); (19) diethyl malonic acid $HOOCC(C_2H_5)_2COOH$ (Aldrich 24,654-9); derivatives of succinic acid, such as (20) mercapto succinic acid $HOOCCH_2CH(SH)COOH$ (Aldrich M618-2); (21) methyl succinic acid $HOOCCH_2CH(CH_3)COOH$ (Aldrich M8,120-9); (22) malic acid $HOOCCH_2CH(OH)COOH$ (Aldrich M121-0); (23) 2,3-dimethyl succinic acid $HOOCCH(CH_3)CH(CH_3)COOH$ (Aldrich D18,620-1); (24) citramalic acid $HOOCCH_2C(CH_3)(OH)COOH$ (Aldrich 32,914-2); (25) (±)-cyclohexyl succinic acid $HOOCCH_2C(C_6H_{11})COOH$ (Aldrich 33,219-4); (26) (±)-2-(carboxymethyl thio) succinic acid $HOOCCH_2CH(SCH_2COOH)COOH$ (Aldrich 28,238-3); (27) tartaric acid $HOOCCH(OH)CH(OH)COOH$ (Aldrich T20-6, T40-0, T-10-9, 25,138-0); derivatives of glutaric acid, such as (28) 2,2-dimethyl glutaric acid $HOOCCH_2CH_2C(CH_3)_2COOH$ (Aldrich 20,526-5); (29) 2,4-dimethyl glutaric acid $HOOCCH(CH_3)$ $CH_2CH(CH_3)$ COOH (Aldrich 23,941-0); (30) 3,3-dimethyl glutaric acid $HOOCCH_2C(CH_3)_2CH_2COOH$ (Aldrich D15,940-9); (31) 2-methyl glutaric acid $HOOCCH_2CH_2CH(CH_3)COOH$ (Aldrich 12,986-0); (32) 3-methyl glutaric acid $HOOCCH_2CH(CH_3)CH_2COOH$ (Aldrich M4,760-4); (33) 3,3-tetramethylene glutaric acid $HOOCCH_2$ $C_5H_8CH_2$ COOH (Aldrich T2,190-3); (34) 3-phenyl glutaric acid $HOOCH_2CC_6H_5CHCH_2COOH$ (Aldrich P2,520-5); (35) 2-ketoglutaric acid $HOOCCH_2CH_2COCOOH$ (Aldrich K160-0); (36) 3-ketoglutaric acid $HOOCCH_2$ $COCH_2$ COOH (Aldrich 16,511-5); derivatives of adipic acid, such as (37) 3-methyl adipic acid $HOOC(CH_2)_2CH(CH_3)CH_2COOH$ (Aldrich M2,740-9); derivatives of pimelic acid, such as (38) (±)-2,6-diamino pimelic acid $HOOCCH(NH_2)(CH_2)_3CH(NH_2)COOH$ (Aldrich 27,147-0); (39) 4-ketopimelic acid $HOOCCH_2CH_2COCH_2CH_2COOH$ (Aldrich K350-6); other derivatives, such as (40) mucic acid (galactaric acid) $HOOC(CHOH)_4COOH$ (Aldrich M8,961-7); (41) 3-methylene cyclopropanetrans-1,2-dicarboxylic acid $H_2C = C-(CHCOOH)_2$ (Aldrich 22,053-1); (42) 1,1-cyclobutane dicarboxylic acid $C_4H_6(COOH)_2$ (Aldrich C9,580-3); (43) cyclohexane dicarboxylic acid $C_6H_{10}(COOH)_2$ (Aldrich 30,703-3, C10,075-7, 33,123-6); (b) compounds of the general formula $R(CH_2COOH)_2$ and their derivatives, wherein R is selected from the group consisting of imine, acetamido imine, alkylimine, oxo, and cycloalkane, including (1) when R = NH, such as imino diacetic acid $NH(CH_2COOH)_2$ (Aldrich 22,000-0); (2) when R = H_2NCOCH_2N, such as [N-(2-acetamido) imino diacetic acid] $H_2NCOCH_2N(CH_2COOH)_2$ (Aldrich 85,760-2); (3) when R = CH_3N, such as methyl iminodiacetic acid $CH_3N(CH_2COOH)_2$ (Aldrich M5,100-8); (4) when R = 0, such as diglycolic acid $0(CH_2COOH)_2$ (Aldrich 14,307-3); (5) when R = C_6H_{10}, such as 1,1-cyclohexane diacetic acid $C_6H_{10}(CH_2COOH)_2$ (Aldrich 17,134-4); (c) compounds of the general formula $HOOC(CH_2)_nCH = CHCOOH$ and their derivatives, wherein n represents the number of repeating units, including (1) [n = 0], such as fumaric acid HOOCCH = CHCOOH (Aldrich 24,074-5, F1 935-3) and (2) maleic acid HOOC-CH = CH-COOH (Aldrich M15-3); (3) [n = 1], such as glutaconic acid $HOOCCH_2CH$ = CHCOOH (Aldrich G260-5); (4) [n = 8], such as 2-dodecenedioic acid $HOOC(CH_2)_8CH = CHCOOH$ (Aldrich 17,724-5); derivatives of fumaric or maleic acid, such as (5) mesaconic acid $HOOCCH = C(CH_3)COOH$ (Aldrich 13,104-6); (6) citraconic acid $HOOC.(CH_3)_C = CHCOOH$ (Aldrich C8,260-4); (7) dihydroxy fumaric acid hydrate $HOOCC(OH) = C(OH)COOH{\cdot}xH_2O$ (Aldrich D11,320-4); and other derivatives, such as (8) trans, trans-1,3-butadiene-1,4-dicarboxylic acid HOOCCH = CHCH = CHCOOH (Aldrich M9,000-3); and the like.

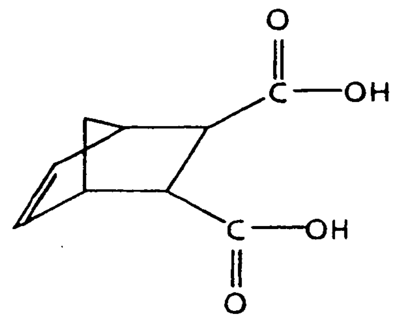
Also suitable are (II) aromatic dicarboxy-functional compounds, such as (1) homophthalic acid $HOOCCH_2C_6H_4COOH$ (Aldrich H1,620-5); (2) terephthalic acid C_6H_4-1,4-$(COOH)_2$ (Aldrich 18,536-1); (3) phthalic acid C_6H_4-1,2-$(COOH)_2$ (Aldrich P3,930-3); (4) 4-methyl phthalic acid $CH_3C_6H_3$-1,2-$(COOH)_2$ (Aldrich 34,830-9); (5) chelidonic acid monohydrate (Aldrich 12,495-8), of the formula:



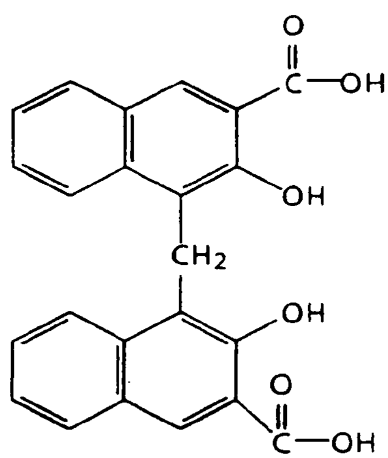
(6) chelidamic acid monohydrate (Aldrich C1,820-5), of the formula:



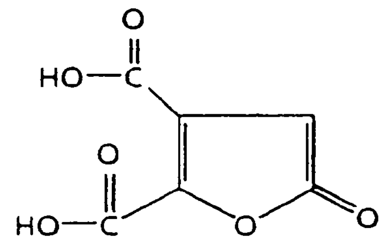
(7) cis-5-norbornene-endo-2,3-dicarboxylic acid (Aldrich 21,670-4), of the formula:;



(8) 1,4-naphthalene dicarboxylic acid $C_{10}H_6(COOH)_2$ (Aldrich 33,358-1); (9) 2,3-naphthalene dicarboxylic acid $C_{10}H_6(COOH)_2$ (Aldrich N40-0); (10) 2,6-naphthalene dicarboxylic acid $C_{10}H_6(COOH)_2$ (Aldrich 30,153-3); (11) 4-carboxy phenoxy acetic acid $HOOCC_6H_4OCH_2COOH$ (Aldrich 18,662-7); (12) 2,5-dihydroxy-1,4-benzene diacetic acid $(HO)_2C_6H_2(CH_2COOH)_2$ (Aldrich D10,920-7); (13) pamoic acid [4,4'-methylene bis (3-hydroxy-2-naphthoic acid)] (Aldrich P9-4), of the formula:

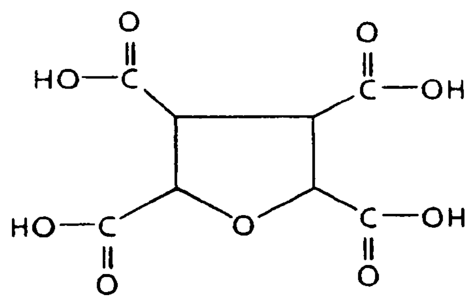


(14) 4-[4-(1-carboxybenzoyl) phenyl] butyric acid $HOOCC_6H_4COC_6H_4 (CH_2)_3COOH$ (Aldrich 19,281-3); (15) 1,4-phenylene diacrylic acid $HOOCCH = CHC_6H_4CH = CHCOOH$ (Aldrich P2,390-3); (16) 2-carboxy cinnamic acid $HOOCC_6H_4CH = CHCOOH$ (Aldrich 18,603-1); (17) γ-L-glutamyl-L-cysteinyl glycine $HOOCCH(NH_2)CH_2CH_2CONHCH(CH_2SH)CONHCH_2COOH$ (Aldrich G470-5); (18) D,L-isocitriclactone [DL-2-oxotetrahydrofuran-4,5-dicarboxylic acid (Aldrich I-1,600-5), of the formula:



(19) N-(2-hydroxyethyl) iminodiacetic acid $HOCH_2CH_2N(CH_2COOH)_2$ (Aldrich 15,814-3); (20) dipivaloyl-L-tartaric acid $([(CH_3)_3CCOOCH(COOH)-]_2$ (Aldrich 33,788-9); (21) (±)-cyclohexyl succinic acid $HOOCCH_2CH(C_6H_{11})COOH$ (Aldrich 33,219-4); (22) phenyl diacetic acid $C_6H_4(CH_2COOH)_2$ (Aldrich 13,140-7, P2,335-0, P2,340-7); and the like.

Also suitable are (III) aliphatic and aromatic compounds with more than two -COOH functional groups, including (1) 1,3,5-cyclohexane tricarboxylic acid $C_6H_9(COOH)_3$ (Aldrich 34,434-6); (2) citric acid monohydrate $HOOCCH_2C(OH)(COOH)CH_2COOH \cdot H_2O$ (Aldrich 24,752-9); (3) 1,2,3-propene tricarboxylic acid $HOOCCH = C(COOH)CH_2COOH$ (Aldrich 27,194-2); (4) 1,2,3-propane tricarboxylic acid $HOOCCH_2CH(COOH)CH_2COOH$ (Aldrich T-5,350-3); (5) β-methyl tricarballyic acid $HOOCCH_2C(CH_3)COOHCH_2COOH$ (Aldrich M8,520-4); (6) 1,2,3,4-cyclobutane tetracarboxylic acid $C_4H_4(COOH)_4$ (Aldrich 32,494-9); (7) 1,2-diaminocyclohexane-N,N, N'N'-tetraacetic acid hydrate $C_6H_{10}[N(CH_2COOH)_2] \cdot xH_2O$ (Aldrich 12581-4); (8) 1,6-diaminohexane-N,N,N'N'-t t-raacetic acid hydrate $(HOOCCH_2)_2N(CH_2)_6N(CH_2COOH)_2 \cdot xH_2O$ (Aldrich 23,245-9); (9) 1,2,4,5-benzene tetracarboxylic acid $C_6H_2(COOH)_4$ (Aldrich B,400-7); (10) 1,4,5,-naphthalene tetracarboxylic acid hydrate $C_{10}H_4(COOH)_4 \cdot xH_2O$ (Aldrich 13009-5); (11) penta diethylene triamine penta acetic acid $(HOOCCH_2)_2NCH_2CH_2(CH_2COOH)CH_2CH_2N(CH_2COOH)_2$ (Aldrich 28,556-0, D9,390-2); (12) mellitic acid $C_6(COOH)_6$ (Aldrich M270-5); (13) agaricic acid (2-hydroxy-1,2,3-nonadecane tricarboxylic acid) $CH_3(CH_2)_{15}CH(COOH)C(OH)(COOH)CH_2COOH$ (Aldrich 21,783-2); (14) 1-2-diamino propane-N,N,N',N'-tetra acetic acid $(HOOCCH_2)NCH(CH_3)CH_2N(CH_2COOH)_2$ (Aldrich 15,813-5); (15) ethylene diamine tetraacetic acid $(HOOCCH_2)_2NCH_2CH_2N(CH_2COOH)_2$ (Aldrich 25,404-5); (16) (±)-2-(caraboxymethylthio) succinic acid $HOOCCH_2CH(SCH_2COOH)COOH$ (Aldrich 28,238-3); (17) N-(2-hydroxyethyl) ethylene diamine triacetic acid $HOCH_2CH_2N(Ch_2COOH)CH_2CH_2N(CH_2COOH)_2$ (Aldrich H2,650-1); (18) N,N'-bis(2-carboxyethyl)-N,N'-ethylene di glycine trihydrate $[-CH_2N(CH_2COOH)CH_2CH_2COOH]_2 \cdot 3H_2O$; (19) tetrahydrofuran-2,3,4,5-tetracarboxylic acid (Aldrich 14,483-5), of the formula:



and the like.

Mixtures of two or more of any of the above compounds can also be employed.

The amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof is present in any effective amount relative to the substrate. Typically, the amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof is present in an amount of from about 1 to about 50 percent by weight of the substrate, preferably from about 5 to about 30 percent by weight of the substrate, although the amount can be outside this range. The amount can also be expr ssed in terms of the weight of amino acid, hydroxy acid, polycarboxyl compound, or mixture ther of per unit area of substrate. Typically, the amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof is present in an amount of from about 0.8 to about 40 grams per square meter of the substrate surface to which it is applied, and preferably from about 4 to about 24 grams per square meter of the substrate surface to which it is applied, although the amount can be outside these ranges.

When the amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof is applied to the substrate

as a coating, the coatings employed for the recording sheets of the present invention can include an optional binder in addition to the amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof. Examples of suitable binder polymers include (a) hydrophilic polysaccharides and their modifications, (b) vinyl polymers, (c) formaldehyde resins, (d) ionic polymers, (e) latex polymers, (f) maleic anhydride and maleic acid containing polymers, (g) acrylamide containing polymrs, and (h) poly(alkylene imine) containing polymers where alkylene has two (ethylene), three (propylene), or four (butylene) carbon atoms , as well as blends or mixtures of any of the above, with starches and latexes being particularly preferred because of their availability and applicability to paper. Numerous examples of such binder polymers are mentioned in U.S. application S.N. 08/196,679, a copy of which was filed with the present application. Any mixtures of the above ingredients in any relative amounts can be employed.

If present, the binder can be present within the coating in any effective amount; typically the binder and the amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof are present in relative amounts of from about 10 percent by weight binder and about 90 percent by weight amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof to about 99 percent by weight binder and about 1 percent by weight amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof, although the relative amounts can be outside of this range.

In addition, the coating of the recording sheets of the present invention can contain optional antistatic agents. Any suitable or desired antistatic agent or agents can be employed, such as quaternary salts and other materials. The antistatic agent can be present in any effective amount; typically, the antistatic agent is present in an amount of from about 1 to about 5 percent by weight of the coating, and preferably in an amount of from about 1 to about 2 percent by weight of the coating, although the amount can be outside these ranges.

Further, the coating of the recording sheets of the present invention can contain one or more optional biocides. Examples of suitable biocides include (A) non-ionic biocides, (B) anionic biocides, (C) cationic biocides, and the like, as well as mixtures thereof. Specific examples of suitable biocides are mentioned in U.S. application S.N. 08/196,679. The biocide can be present in any effective amount; typically, the biocide is pres nt in an amount of from about 10 parts per million to about 3 percent by weight of the coating, although the amount can be outside this range.

Additionally, the coating of the recording sheets of the present invention can contain optional filler components. Fillers can be present in any effective amount, and if present, typically are present in amounts of from about 1 to about 60 percent by weight of the coating composition. Examples of filler components include colloidal silicas, such as Syloid 74, available from Grace Company (preferably present, in one embodiment, in an amount of about 20 weight percent). Brightener fillers can enhance color mixing and assist in improving print-through in recording sheets of the present invention.

The coating containing the amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof is present on the substrate of the recording sheet of the present invention in any effective thickness. Typically, the total thickness of the coating layer (on each surface, when both sides of the substrate are coated) is from about 1 to about 25 μm and preferably from about 5 to about 10 μm, although the thickness can be outside of these ranges.

The amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof, or the mixture of amino acid, hydroxy acid, polycarboxyl compound, or mixture thereof with an optional binder, optional antistatic agent, optional biocide, and/or optional filler can be applied to the substrate by any suitable technique, such as size press treatment, dip coating, reverse roll coating, extrusion coating, or the like. For example, the coating can be applied with a KRK size press (Kumagai Riki Kogyo Co., Ltd., Nerima, Tokyo, Japan) by dip coating and can be applied by solvent extrusion on a Faustel Coater. The KRK size press is a lab size press that simulates a commercial size press. This size press is normally sheet fed, whereas a commercial size press typically employs a continuous web. On the KRK size press, the substrate sheet is taped by one end to the carrier mechanism plate. The speed of the test and the roll pressures are set, and the coating solution is poured into the solution tank. A 4 liter stainless steel beaker is situated underneath for retaining the solution overflow. The coating solution is cycled once through the system (without moving the substrate sheet) to wet the surface of the rolls and then returned to the feed tank, where it is cycled a second time. While the rolls are being "wetted", the sheet is fed through the sizing rolls by pressing the carrier mechanism start button. The coated sheet is then removed from the carrier mechanism plate and is placed on a 12 inch by 40 inch (30.5x102cm) sheet of 750 μm thick Teflon for support and is dried on the Dynamic Former drying drum and held under restraint to prevent shrinkage. The drying temperatur is approximately 105°C. This method of coating treats both sides of the substrate simultaneously.

In dip coating, a web of the material to be coated is transported below the surface of the liquid coating composition by a single roll in such a manner that the exposed site is saturated, followed by removal of any excess coating by the sque ze rolls and drying at 100°C in an air dryer. The liquid coating composition gen-

erally comprises the desired coating composition dissolved in a solvent such as water, methanol, or the like. The method of surface treating the substrate using a coater results in a continuous sheet of substrate with the coating material applied first to one side and then to the second side of this substrate. The substrate can also be coated by a slot extrusion process, wherein a flat die is situated with the die lips in close proximity to the web of substrate to be coated, resulting in a continuous film of the coating solution evenly distributed across one surface of the sheet, followed by drying in an air dryer at 100°C.

Recording sheets of the present invention can be employed in ink jet printing processes. Ink jet printing processes are well known, and are described in, for example, US-A-4,601,777, US-A-4,251,824, US-A-4,410,899, US-A-4,412,224, and US-A-4,532,530. In a particularly preferred embodiment, the printing apparatus employs a thermal ink jet process wherein the ink in the nozzles is selectively heated in an imagewise pattern, thereby causing droplets of the ink to be ejected in imagewise pattern. In another preferred embodiment, the substrate is printed with an aqueous ink and thereafter the printed substrate is exposed to microwave radiation, thereby drying the ink on the sheet. Printing processes of this nature are disclosed in, for example, U.S. Patent 5,220,346, the disclosure of which is totally incorporated herein by reference.

The recording sheets of the present invention can also be used in any other printing or imaging proc ss, such as printing with pen plotters, handwriting with ink pens, offset printing processes, or the like, provided that the ink employed to form the image is compatible with the ink receiving layer of the recording sheet.

Recording sheets of the present invention exhibit reduced curl upon being printed with aqueous inks, particularly in situations wherein the ink image is dried by exposure to microwave radiation. Generally, the term "curl" refers to the distance between the base line of the arc formed by recording sheet when viewed in cross-section across its width (or shorter dimension - for example, 8.5 inches (21.6cm) in an 8.5 × 11 inch (21.6x27.9) sheet, as opposed to length, or longer dimension - for example, 11 inches (27.9cm) in an 8.5 × 11 inch (21 .6x27.9cm) sheet) and the midpoint of the arc. To measure curl, a sheet can be held with the thumb and forefinger in the middle of one of the long edges of the sheet (for example, in the middle of one of the 11 inch (27.9cm) edges in an 8.5 × 11 inch (21.6x27.9cm) sheet) and the arc formed by the sheet can be matched against a pre-drawn standard template curve.

Specific embodiments of the invention will now be described in detail. These examples are intended to be illustrative, and the invention is not limited to the materials, conditions, or process parameters set forth in these embodiments. All parts and percentages are by weight unless otherwise indicated.

The optical density measurements recited herein were obtained on a Pacific Spectrograph Color System. The system consists of two major components, an optical sensor and a data terminal. The optical sensor employs a 6 inch (15cm) integrating sphere to provide diffuse illumination and 8 degrees viewing. This sensor can be used to measure both transmission and reflectance samples. When reflectance samples are measured, a specular component may be included. A high resolution, full dispersion, grating monochromator was used to scan the spectrum from 380 to 720 nanometers. The data terminal features a 12 inch (30cm) CRT display, numerical keyboard for selection of operating parameters and the entry of tristimulus values, and an alphanumeric keyboard for entry of product standard information.

EXAMPLE I

Transparency sheets were prepared as follows. Blends of 70 percent by weight hydroxypropyl methyl cellulose (K35LV, obtained from Dow Chemical Co.) and 30 percent by weight of various additive compositions, each obtained from Aldrich Chemical Co., were prepared by mixing 56 grams of hydroxypropyl methyl cellulose and 24 grams of the additive composition in 1,000 milliliters of water in a 2 Liter jar and stirring the contents in an Omni homogenizer for 2 hours. Subsequently, the solution was left overnight for removal of air bubbles. The blends thus prepared were then coated by a dip coating process (both sides coated in one operation) by providing Mylar® base sheets in cut sheet form (8.5 × 11 inches (21.6x27.9cm)) in a thickness of 100 μm. Subsequent to air drying at 25°C for 3 hours followed by oven drying at 100°C for 10 minutes and monitoring the difference in weight prior to and subsequent to coating, the dried coated sheets were each coated with 1 gram, 10 μm in thickness, on each surface (2 grams total coating weight for 2-sided transparency) of the substrate. For comparison purposes, a transparency sheet was also prepared in which the coating consisted of 100 percent by weight hydroxypropyl methyl cellulose and contained no additive composition.

The transparency sheets thus prepared were incorporated into a Hewlett-Packard 500-C color ink jet printer containing inks of the following compositions:

Cyan: 20 percent by weight ethylene glycol, 2.5 percent by weight benzyl alcohol, 1.9 percent by weight ammonium chloride, 0.1 percent by w ight Dowicil 150 biocide, obtained from Dow Chemical Co., Midland, MI, 0.05 percent by weight polyethylene oxide (molecular weight 18,500), obtained from Union Carbide Co.), 30 percent by weight Projet Cyan 1 dye, obtained from ICI, 45.45 percent

by weight water.

Magenta: 20 percent by weight ethylene glycol, 2.5 percent by weight benzyl alcohol, 1.9 percent by weight ammonium chloride, 0.1 percent by weight Dowicil 150 biocide, obtained from Dow Chemical Co., Midland, MI, 0.05 percent by weight polyethylene oxide (molecular weight 18,500), obtained from Union Carbide Co.), 2.5 percent by weight Triton Direct Red 227, obtained from Tricon, 72.95 percent by weight water.

Yellow: 20 percent by weight ethylene glycol, 2.5 percent by weight benzyl alcohol, 1.9 percent by weight ammonium chloride, 0.1 percent by weight Dowicil 150 biocide, obtained from Dow Chemical Co., Midland, MI, 0.05 percent by weight polyethylene oxide (molecular weight 18,500), obtained from Union Carbide Co.), 3 percent by weight Hoechst Duasyn Brilliant Yellow SF-GL VP220, obtained from Hoechst, 72.45 percent by weight water.

Images were generated by printing block patterns for magenta, cyan, yellow, and black. The images thus formed were dried by exposure to microwave radiation with a Citizen Model No. JM55581, obtained from Consumers, Mississauga, Ontario, Canada, set at 700 Watts output power at 2450 MHz frequency. The black images were "process black" (i.e., formed by superimposition of cyan, magenta, and yellow images). The drying times and optical densities for the resulting images were as follows:

Additive	Drying Time (seconds)				Optical Density			
	black	cyan	magenta	yellow	black	cyan	magenta	yellow
none	30	20	30	20	2.50	2.07	1.45	0.99
D,L-2-amino butyric acid	20	30	30	20	1.70	1.70	1.50	0.98
L-arginine hydrochloride	10	30	30	[illegible]	1.80	2.10	1.65	0.95
N-acetyl-D,L-methionine	10	40	10	20	1.88	1.70	1.49	0.94
L-tartaric acid	20	20	30	30	2.00	1.80	1.41	0.87
3-hydroxy benzoic acid	20	20	25	20	1.95	1.80	1.45	0.92

As the results indicate, the drying times for the process black images in all cases was faster in the presenc of the additives than in their absence. In addition, all of the images exhibited acceptable optical densities.

EXAMPLE II

Transparency sheets were prepared as follows. Blends of 90 percent by weight hydroxypropyl methyl c l-lulose (K35LV, obtained from Dow Chemical Co.) and 10 percent by weight of various additive compositions, each obtained from Aldrich Chemical Co., were prepared by mixing 72 grams of hydroxypropyl methyl cellulose and 8 grams of the additive composition in 1,000 milliliters of water in a 2 Liter jar and stirring the contents in an Omni homogenizer for 2 hours. Subsequently, the solution was left overnight for removal of air bubbles. The blends thus prepared were then coated by a dip coating process (both sides coated in one operation) by providing Mylar® base sheets in cut sheet form (8.5 × 11 inches (21.6x27.9cm)) in a thickness of 100 μm. Subsequent to air drying at 25°C for 3 hours followed by oven drying at 100°C for 10 minutes and monitoring the difference in weight prior to and subsequent to coating, the dried coated sheets were each coated with 1 gram, 10 μm in thickness, on each surface (2 grams total coating weight for 2-sided transparency) of the substrate. For comparison purposes, a transparency sheet was also prepared in which the coating consisted of 100 percent by weight hydroxypropyl methyl cellulose and contained no additive composition.

The transparency sheets thus prepared were incorporated into a Hewlett-Packard 500-C color ink jet printer containing inks of the following compositions:

Cyan: Same as Example I.
Magenta: Same as Example I.
Yellow: Same as Example I.

Images were generated by printing block patterns for magenta, cyan, yellow, and black. The images thus formed were allowed to dry at 25°C. The black images were "process black" (i.e., formed by superimposition of cyan, magenta, and yellow images). The drying times and optical densities for the resulting images were as follows:

Additive	Drying Time (minutes)				Optical Density			
	black	cyan	magenta	yellow	black	cyan	magenta	yellow
none	10	5	5	2	2.95	2.10	1.37	0.99
D,L-2-amino butyric acid	6	3	3	1	2.80	2.08	1.30	0.90
L-arginine hydrochloride	6	3	3	1	2.80	1.68	1.27	0.90
D,L-threonine	7	3.5	3.5	1.5	2.40	1.81	0.90	0.77
N-acetyl-D,L-methionine	6	3	3	1.5	2.30	1.60	1.24	0.91
β-alanine	7	3	3.5	2	2.80	2.20	1.25	0.90
D,L-alanine	7	3	3.5	2	2.70	1.75	1.28	0.97
D,L-serine	7	3	3.5	2	2.30	1.75	1.02	0.90
D,L-norleucine	7	4	3	2	2.60	1.80	1.12	0.85
L-tartaric acid	6	3	3	1.5	1.60	1.68	1.45	1.01
2-hydroxy cinnamic acid (methanol)	6	3	3	1.5	1.60	1.70	1.28	1.06
3,4-dihydroxy cinnamic acid (methanol)	6	3	3	1.5	1.95	2.05	1.27	1.07
3-hydroxy benzoic acid	7	4	3	1.5	1.60	1.47	1.20	1.07

As the results indicate, the drying times of the transparencies containing the additives was generally faster than the drying times of the transparencies containing no additives, while optical densities of images formed on the transparencies containing the additives remained acceptable.

EXAMPLE III

Paper recording sheets were prepared as follows. Coating compositions containing various additive compositions, each obtained from Aldrich Chemical Co., were prepared by dissolving 50 grams of the additive in 500 milliliters of water in a beaker and stirring for 1 hour at 25°C. The additive solutions thus prepared were then coated onto paper by a dip coating process (both sides coated in one operation) by providing paper base sheets in cut sheet form (8.5 × 11 inches (21.6x27.9cm)) in a thickness of 100 mm. Subsequent to air drying at 100°C for 10 minutes and monitoring the difference in weight prior to and subsequent to coating, the sheets were each coated on each side with 500 milligrams, in a thickness of 5 μm (total coating weight 1 gram for two-sided sheets), of the additive composition. For comparison purposes, an uncoated paper sheet treated with a composition containing only water by the same procedure was also imaged.

The paper sheets thus prepared were incorporated into a Hewlett-Packard 500-C color ink jet printer containing inks of the following composition:

Cyan: Same as Example I.
Magenta: Same as Example I.
Yellow: Same as Example 1.

Images were generated with 100 percent ink coverage. After the image was printed, the paper sheets were each weighed precisely in a precision balance at time zero and periodically after that. The difference in weight was recorded as a function of time, 100 minutes being considered as the maximum time required for most of the volatile ink components to evaporate. (Volatiles were considered to be ink components such as water and glycols that can evaporate, as compared to components such as dyes, salts, and/or other non-volatile components. Knowing the weight of ink deposited at time zero, the amount of volatiles in the image can be calculated.) After 1000 minutes, the curl values of thepaper were measured and are listed in the Table below. The black images were "process black" (i.e., formed by superimposition of cyan, magenta, and yellow images).

Additive	Percent weight-loss of volatiles at various times (minutes)						1,000 minutes	
	5	10	15	30	60	120	wt. loss %	curl in mm
none	32	43	45	48	50	53	65	125
D,L-2-amino butyric acid	39	51	57	60	64	67	72	30
L-arginine hydrochloride	37	50	54	58	63	66	81	20
D,L-threonine	31	48	55	59	61	65	80	20
N-acetyl-D,L-methionine	38	50	55	59	64	68	90	10
β alanine	27	40	45	47	50	54	83	20
L-tartaric acid	33	49	55	60	64	68	86	15
2-hydroxycinnamic acid	31	47	51	56	58	64	87	15
3-hydroxy benzoic acid	37	52	57	61	63	67	94	5
3,4-dihydroxy cinnamic acid	35	48	52	55	58	64	86	15

As the results indicate, the papers containing the additives exhibited higher weight loss values at tim 1,000 minutes compared to the paper which had been treated with water alone. In addition, the papers coated with the salts exhibited lower curl values compared to the curl value for the paper treated with water alone.

EXAMPLE IV

Paper recording sheets were prepared as follows. Coating compositions containing various salt compositions, each obtained from Aldrich Chemical Co., were prepared by dissolving 50 grams of the salt in 500 milliliters of water in a beaker and stirring for 1 hour at 25°C. The salt solutions thus prepared were then coated ontopaper by a dip coating process (both sides coated in one operation) by providing paper base sheets in cut sheet form (8.5 × 11 inches (21.6x27.9cm)) in a thickness of 100 μm. Subsequent to air drying at 100°C for 10 minutes and monitoring the difference in weight prior to and subsequent to coating, the sheets were each coated on each side with 500 milligrams, in a thickness of 5 μm (total coating weight 1 gram for two-sided sheets), of the salt composition For comparison purposes, an uncoated paper sheet treated with a composition containing only water by the same procedure was also imaged.

The paper sheets thus prepared were incorporated into a Hewlett-Packard 500-C color ink jet printer containing inks of the following composition:

Cyan: Same as Example I.
Magenta: Same as Example 1.
Yellow: Same as Example I.

The black images were "process black" (i.e., formed by superimposition of cyan, magenta, and yellow images). The optical densities for the resulting images were as follows:

Additive	Optical Density			
	black	cyan	magenta	yellow
none	1.08	1.18	1.03	0.80
D,L-2-amino butyric acid	1.26	1.28	1.13	0.78
L-arginine hydrochloride	1.26	1.20	1.15	0.79
D,L-threonine	1.24	1.30	1.08	0.79
N-acetyl-D,L-methionine	1.04	1.05	0.86	0.68
β-alanine	1.20	1.10	1.15	0.80
L-tartaric acid	1.02	1.00	0.84	0.70
2-hydroxycinnamic acid	1.03	1.16	0.70	0.65
3-hydroxy benzoic acid	1.03	1.15	0.71	0.66
3,4-dihydroxy cinnamic acid	1.01	1.11	0.69	0.68

As the results indicate, the papers coated with the additive compositions exhibited acceptable optical densities for all colors.

Claims

1. A recording sheet which comprises a substrate, for example paper or a transparent polymeric material, and an additive material selected from the group consisting of monomeric amino acids, monomeric hydroxy acids, monomeric polycarboxyl compounds and mixtures thereof.

2. A recording sheet according to claim 1 wherein the additive material is present on the substrate in an amount of (1) from about 1 to about 50 percent by weight of the substrate, and/or (2) from about 0.8 to about 40 grams per square meter of the substrate.

3. A recording sheet according to claim 1 or 2, further including a binder, the binder comprising (1) a polysaccharide, or (2) a quaternary acrylic copolymer latex.

4. A recording sheet according to claim 3 wherein a binder and the additive material (1) are present in relative amounts of from about 10 percent by weight binder and about 90 percent by weight additive material to about 99 percent by weight binder and about 1 percent by weight additive material, and/or (2) are coated onto the substrate in a thickness of from about 1 to about 25 μm.

5. A recording sheet according to any of claims 1 to 4, wherein the additive is (A) an amino acid, (B) a hydroxy acid, (C) a polycarboxyl compound, (D) of the general formula R_1-$(CH_2)_n$-CH_2-(NHR_2)-COOH, wherein R_1 is selected from the group consisting of alkyl, phenyl, hydroxyl, mercaptyl, sulfonic acid, alkyl sulfonic acid, alkyl mercaptyl, phenol, thio, carboxyl, indole, acetamide alkane, 1-alkyl indole, imidazole, aminophenyl, carboxy alkyl, amido alkyl, glutamyl, amino carbonyl, alkyl thio alkyl, amino alkyl, dihydroxy phenyl, vinyl, allyl, amino sulfamoyl, guanidyl alkane, benzyloxy phenyl, S-carbamyl, dicarboxy alkyl, carbobenzyloxy amine, S-trityl, tert-alkoxy carbonyl amine, S-tert alkylthio, S-carboxyalkyl, alkyl sulfoxide alkane, alkyl sulfoximine, hydroxy alkyl, mercaptyl alkyl, thiazolyl, aminoalkane, and amine, R_2 is selected from the group consisting of hydrogen, carbobenzyloxy, glycyl, N-tert-butoxy carbonyl, and acetyl, and n represents the number of repeating units, (E) selected from the group consisting of alanine; 2-aminobutyric acid; norvaline; norleucine; 2-amino caprylic acid; 2-phenyl glycine; phenyl alanine; homophenyl alanine; serine; cysteine; cysteic acid monohydrate; homocysteic acid; leucine; tyrosine; cystine; aspartic acid; leucenol; acetyllysine; tryptophan; trityl-L-cysteine; 1-methyl tryptophan; histidine; 4-amino phenylalanine hydrate; glutamic acid; glutamine; γ-glutamyl-glutamic acid; N-(γ-glutamyl) phenylalanine; asparagine; citrulline; ethionine; lysine; lysine hydrate; 3-(3,4-dihydroxy phenyl)-alanine; 2-amino-4 pentanoic acid; 2-amino-4-sulfamoyl butyric acid; arginine; carbobenzyl-tyrosine; carbamyl-cysteine; N-ε(tert-butoxy car-

bonyl)-lysine; (tert butylthio)-cysteine; γ-carboxy glutamic acid; N-carbobenzyloxy-lysine; carboxymethyl-cysteine; methionine; methionine sulfoxide; methionine sulfoximine; homoserine; homocysteine; 3-(2-thiazolyl)-alanine; glycyl glycyl tyrosine dihydrate; glycyl-glutamic acid; threonine; valine; isoleucine; 4-hydroxy phenyl glycine; 3-hydroxynorvaline; N-acetyl-glutamic acid; N-acetyl-methionine; N-α-acetyl-histidine monohydrate; N-acetyl tryptophan; N-acetyl-cysteine; N-acetyl-phenylalanine; N-acetylpenicil-lamine; 2-aminobutyric acid; α-methyl tyrosine; 3-(3,4-dihydroxyphenyl)-2-methylalanine sesquihydrate; α-methyl-phenylalanine; alanyl-norvaline; alanyl-phenyl alanine; N-(tert-butoxy carbonyl)-isoleucine; N-α-(tert butoxy carbonyl)-lysine; N-(tert-butoxy carbonyl)-phenylalanine; N-(tert-butoxy carbonyl)-serine; N-(tert-butoxy carbonyl)-threonine; N-(tert-butoxy carbonyl)-valine; carbobenzyloxy-alanine; N-carbo-benzyloxy-arginine; carbobenzyloxy-asparagine; N-carbobenzyloxy-aspartic acid; carbobenzyloxy-gluta-mine; N-(carbobenzyloxy)-lysine; N-(carbobenzyloxy)-phenylalanine; carbobenzyloxy-serine; carboben-zyloxy-valine; and mixtures thereof, (F) of the general formula R_1-$(CH_2)_n$-CH_2-(NHR_2)-$COOH{\cdot}HX$, wherein R_1 is selected from the group consisting of amine, amino alkane, guanidyl alkane, and phenyl alkyl, R_2 is hydrogen or alkyl, and X is an anion, or (G) selected from the group consisting of 2,3-diamino propionic acid monohydrochloride; 2,3-diamino propionic acid monohydrobromide; ornithine hydrochloride; homo-arginine hydrochloride; arginine hydrochloride; 2,4-diaminobutyric acid dihydrochloride; lysine monohy-drochloride; lysine dihydrochloride; β-methyl-phenyl alanine hydrochloride; 2-methylornithine hydrochlor-ide monohydrate; and mixtures thereof.

6. A recording sheet according to any of claims 1 to 4, wherein the additive is (A) of the general formula H_2N-R-COOH, wherein R is selected from the group consisting of alkane, phenyl, benzyl, alkyl phenyl, phenyl dialkoxy, alkyl cycloalkane, phenol, aminophenyl, diamino phenyl, glycyl, amino benzoyl alkane, amino cycloalkane, methoxy, amino benzophenone, imino phenyl, acetyl alkane, phenyl alkene, phenyl amido alkane, hydroxy alkyl phenyl, dialkyl hydroxy alkyl amino alkane, and benzyl carbonyl, (B) selected from the group consisting of glycine; glycine hydrochloride; β-alanine; 4-aminobutyric acid; 5-aminovaleric acid; 5-aminovaleric acid hydrochloride; 6-amino caproic acid; 7-aminoheptanoic acid; 8-amino caprylic acid; 11-amino undecanoic acid; 12-amino dodecanoic acid; amino benzoic acid; 3-amino benzoic acid hydro-chloride; 4-amino phenyl acetic acid; 4-amino methyl benzoic acid; 5-amino-2-methyl benzoic acid; 2-ami-no-4,5-dimethoxy benzoic acid; 4-amino methyl cyclohexane carboxylic acid; 5-amino salicyclic acid; 3,5-diaminobenzoic acid; 4-aminohippuric acid; glycyl glycine; glycyl glycyl glycyl glycine; N-(4-aminoben-zoyl)-β-alanine; N-(4-aminobenzoyl)-6-aminocaproic acid; 5-amino isophthalic acid; 1-amino-1-cyclopen-tane carboxylic acid; 1-amino-1-cyclopropane carboxylic acid hemihydrate; 1-amino-1-cyclopropane car-boxylic acid hydrochloride; 4-amino cinnamic acid hydrochloride; succinamic acid; carboxymethoxylamine hemihydrochloride; 2-hydrazino benzoic acid hydrochloride; allantoic acid; 2-aminobenzophenone-2'-car-boxylic acid; creatine monohydrate; and mixtures thereof, (C) an imino acid containing -NH and -COOH groups, (D) selected from the group consisting of n-trityl glycine; 2-acetamido acrylic acid; 4-acetamido benzoic acid; α-acetamido cinnamic acid; 6-acetamido hexanoic acid; acetamido acetic acid; N-(2-mer-capto propionyl) glycine; and mixtures thereof, (E) of the general formula H_2N-(R)-SO_3H, wherein R is se-lected from the group consisting of alkane, alkylene oxide, phenyl, naphthyl, amino benzene, and aceta-mido alkane, (F) selected from the group consisting of sulfamic acid; amino methane sulfonic acid; α-2-aminoethane sulfonic acid; 3-amino-1-propane sulfonic acid; 2-amino ethyl hydrogen sulfate; sulfanilic acid; 2-amino-1-naphthalene sulfonic acid; 2,5-diamino benzene sulfonic acid; N-(2-acetamido) 2-amino ethane sulfonic acid; and mixtures thereof, or (G) of the general formula $NH_2(R)P(O)(OH)_2$, wherein R is selected from the group consisting of alkylene oxide, alkane, and phenyl.

7. A recording sheet according to any of claims 1 to 4, wherein the additive is (A) selected from the group consisting of 2-amino ethyl dihydrogen phosphate; 2-aminoethyl phosphonic acid; 3-aminopropyl phos-phonic acid; 4-amino phenyl phosphonic acid; and mixtures thereof, (B) of the general formula HO[R]XH, wherein R is selected from the group consisting of alkane, cycloalkane, phenyl, alkoxy phenyl, dialkoxy phenyl, alkyl phenyl, and phenyl alkene and X is an anion, (C) selected from the group consisting of glycolic acid; 10-hydroxydecanoic acid; 12-hydroxydodecanenoic acid; 16-hydroxy hexadecanoic acid; 1-hy-droxy-1-cyclopropane carboxylic acid; hydroxy benzoic acid; 3-hydroxy-4-methoxy benzoic acid; 4-hy-droxy-3-methoxy benzoic acid; 4-hydroxy-3,5-dimethoxy benzoic acid; 3-hydroxy-4,5-dimethoxy benzoic acid; 2-hydroxy-3-isopropyl-6-methyl benzoic acid; 2-hydroxy-6-isopropyl-3-methyl benzoic acid; hydroxy cinnamic acid; 3-hydroxy-4-methoxy cinnamic acid; 4-hydroxy-3-methoxy cinnamic acid; 3,5-dimethoxy-4-hydroxy cinnamic acid; 2-hydroxyhippuric acid; hydroxy phenyl acetic acid; 4-hydroxy-3-methoxy phe-nyl acetic acid; 3-(4 hydroxyphenyl) lactic acid hydrate; 4-hydroxyphenyl pyruvic acid; 4-hydroxy benzene sulfonic acid; 3[(1,1-dimethyl-2-hdyroxyethyl) amino]-2-hydroxy propane sulfonic acid; and mixtures

thereof, (D) of the general formula $R_1R_2(OH)COOH$, wherein R_1 and R_2 are each independently selected from the group consisting of alkyl, dialkyl, phenyl, alkoxy, halide, hydroxy, phenyl, dihalide vinyl acrylamide, cycloalkane, and halogenated hydroxyl phenyl, (E) selected from the group consisting of lactic acid; 3-hydroxybutyric acid; 2-hydroxyisobutyric acid; 2-ethyl-2 hydroxybutyric acid; 2-hydroxy-3-methyl butyric acid; 2-hydroxy-2-methyl butyric acid; 2-hydroxy caproic acid; hydroxyisocaproic acid; mandelic acid; 4-methoxy mandelic acid; 4-bromo mandelic acid; 3-hydroxy-4-methoxy mandelic acid; 4-hydroxy-3-methoxy mandelic acid; 4-hydroxy mandelic acid monohydrate; 3-chloro-4-hydroxy benzoic acid hemihydrate; 2-hydroxy-3-isopropyl benzoic acid; 3,5-dibromohydroxy benzoic acid; 3,5-dichloro hydroxy benzoic acid; benzilic acid; 2-(4-hydroxy phenoxy) propionic acid; α-hydroxy hippuric acid; 3,5-diisopropyl salicylic acid; 3-chloro-4-hydroxy phenyl acetic acid; 12-hydroxystearic acid; tropic acid; 2-acrylamido glycolic acid monohydrate; hexahydromandelic acid; and mixtures thereof, (F) of the general formula $(HO)_2$ RCOOH, wherein R is selected from the group consisting of phenyl, acrylic phenyl, phenyl alkyl, phenyl hydroxy, alkyl, naphthyl, alkane amine, diphenyl alkyl, and amino alkyl, or (G) selected from the group consisting of dihydroxy benzoic acid; 3,4-dihydroxy cinnamic acid; 3,4-dihydroxy hydro cinnamic acid; 3,4-dihydroxy mandelic acid; 3,5-dihydroxy-4-methyl benzoic acid hemihydrate; dihydroxy naphthoic acid; dihydroxy phenylacetic acid; bicine; 2,2-bis(hydroxymethyl)propionic acid; 4,4-bis(4-hydroxyphenyl) valeric acid; tris (hydroxymethyl) amino methane succinate; and mixtures thereof.

8. A recording sheet according to any of claims 1 to 4, wherein the additive is (A) an aliphatic dicarboxy-functional compound, (B) selected from the group consisting of oxalic acid; malonic acid; succinic acid; glutaric acid; adipic acid; pimelic acid; suberic acid; azelaic acid; sebacic acid; undecanedioic acid; 1,10-decane dicarboxylic acid; 1,11-undecane dicarboxylic acid; 1,12,dodecane dicarboxylic acid; hexadecanedioic acid; tetracosane dioic acid; methyl malonic acid; ketomalonic acid monohydrate; ethyl malonic acid; diethyl malonic acid; mercapto succinic acid; methyl succinic acid; malic acid; 2,3-dimethyl succinic acid; citramalic acid; cyclohexyl succinic acid; 2-(carboxymethyl thio) succinic acid; tartaric acid; 2,2-dimethyl glutaric acid; 2,4-dimethyl glutaric acid; 3,3-dimethyl glutaric acid; 2-methyl glutaric acid; 3-methyl glutaric acid; 3,3-tetramethylene glutaric acid; 3-phenyl glutaric acid; 2-ketoglutaric acid; 3-ketoglutaric acid; 3-methyl adipic acid; 2,6-diamino pimelic acid; 4-ketopimelic acid; mucic acid; 3-methylene cyclopropane-trans-1,2-dicarboxylic acid; 1,1-cyclobutane dicarboxylic acid; cyclohexane dicarboxylic acid; imino diacetic acid; [N-(2-acetamido) imino diacetic acid]; methyl iminodiacetic acid; diglycolic acid; 1,1-cyclohexane diacetic acid; fumaric acid; maleic acid; glutaconic acid; 2-dodecenedioic acid; mesaconic acid; citraconic acid; dihydroxy fumaric acid hydrate; trans, trans-1,3-butadiene-1,4-dicarboxylic acid; and mixtures thereof, (C) an aromatic dicarboxy-functional compound, (D) selected from the group consisting of homophthalic acid; terephthalic acid; phthalic acid; 4-methyl phthalic acid; chelidonic acid monohydrate; chelidamic acid monohydrate; cis-5-norbornene-endo-2,3-dicarboxylic acid; 1,4-naphthalene dicarboxylic acid; 2,3-naphthalene dicarboxylic acid; 2,6-naphthalene dicarboxylic acid; 4-carboxy phenoxy acetic acid; 2,5-dihydroxy-1,4-benzene diacetic acid; pamoic acid; 4-[4-(2-carboxybenzoyl) phenyl] butyric acid; 1,4-phenylene diacrylic acid; 2-carboxy cinnamic acid; γ-glutamyl-L-cysteinyl glycine; isocitriclactone [2-oxotetrahydrofuran-4,5-dicarboxylic acid; N-(2-hydroxyethyl) iminodiacetic acid; dipivaloyl-tartaric acid; cyclohexyl succinic acid; phenyl diacetic acid; and mixtures thereof, (E) a polycarboxyl compound having more than 2 -COOH groups, or (F) selected from the group consisting of 1,3,5-cyclohexane tricarboxylic acid; citric acid monohydrate; 1,2,3-propene tricarboxylic acid; 1,2,3-propane tricarboxylic acid; β-methyl tricarballyic acid; 1,2,3,4-cyclobutane tetracarboxylic acid; 1,2-diaminocyclohexane-N,N,N'N'-tetraacetic acid hydrate; 1,6-diaminohexane-N,N,N'N'-tetraacetic acid hydrate; 1,2,4,5-benzene tetracarboxylic acid; 1,4,5,8-naphthalene tetracarboxylic acid hydrate; penta diethylene triamine penta acetic acid; mellitic acid; agaricic acid; 1-2-diamino propane-N,N,N',N'-tetra acetic acid; ethylene diamine tetraacetic acid; 2-(caraboxymethylthio) succinic acid; N-(2-hydroxyethyl) ethylene diamine triacetic acid; N,N'-bis(2-carboxyethyl)-N,N'-ethylene di glycine trihydrate; tetrahydrofuran-2,3,4,5-tetracarboxylic acid; and mixtures thereof.

9. A process which comprises applying an aqueous recording liquid in an imagewise pattern to a recording sheet according to any of the preceding claims, the process preferably comprising (1) incorporating the recording sheet into an ink jet printing apparatus containing an aqueous ink, and (2) causing droplets of the ink to be ejected in an imagewise pattern onto the recording sheet, thereby generating images on the recording sheet.

10. A process according to claim 9 wherein the recording sheet is printed with an aqueous ink and thereafter the printed substrate is exposed to microwave radiation, thereby drying the ink on the sheet.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 0919

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	DATABASE WPI Section Ch, Week 8721, Derwent Publications Ltd., London, GB; Class E19, AN 87-147635 & JP-A-62 085 982 (CANON KK) 20 April 1987 * abstract *	1,2,5,6,9 10	B41M5/00 D21H17/14
X	US-A-4 775 594 (DESJARLAIS) * column 4 - column 5 *	1-5,8,9	
X	DATABASE WPI Section Ch, Week 8840, Derwent Publications Ltd., London, GB; Class A97, AN 88-281436 & JP-A-63 205 276 (NIPPON SHOKUBAI KAGAKU) 24 August 1988 * abstract *	1,5,7,9	
X	DATABASE WPI Section Ch, Week 8841, Derwent Publications Ltd., London, GB; Class A89, AN 88-288579 & JP-A-63 209 884 (HONSHU PAPER MFG KK) 31 August 1988	1,3,5,7	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B41M D21H
D,Y	US-A-5 220 346 (CARREIRA ET AL.) * claim 1 *	10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 May 1995	Bernardo Noriega, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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